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(54) **SYSTEM FOR SUPPLYING FLUID TO TRANSMISSION CONTROL ELEMENTS**

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F16H 63/30	(2006.01)
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F16D 48/02	(2006.01)
F16H 3/44	(2006.01)
F16H 57/08	(2006.01)

(52) **U.S. Cl.**

CPC ***F16H 57/043*** (2013.01); ***F16D 25/0638*** (2013.01); ***F16D 25/10*** (2013.01); ***F16D 48/0206*** (2013.01); ***F16H 57/0473*** (2013.01); ***F16H 57/0484*** (2013.01); ***F16H 63/3026*** (2013.01); *F16D 2048/0224* (2013.01); *F16H 3/66* (2013.01); *F16H 2003/447* (2013.01); *F16H 2057/087* (2013.01); *F16H 2200/2012* (2013.01); *F16H 2200/2046* (2013.01)

(58) **Field of Classification Search**

CPC F16H 63/3026; F16H 57/0473; F16H 57/043; F16H 2057/087; F16D 25/10; F16D 2048/0224

USPC 192/48.609, 48.611, 48, 614, 48.618, 192/48.619, 85.25, 3.25, 3.3

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

3,053,115	A *	9/1962	Cartwright et al.	475/159
3,730,022	A *	5/1973	O'Malley	475/146
4,449,422	A *	5/1984	Fuehrer et al.	74/606 R
2009/0247343	A1 *	10/2009	Hart et al.	475/31

* cited by examiner

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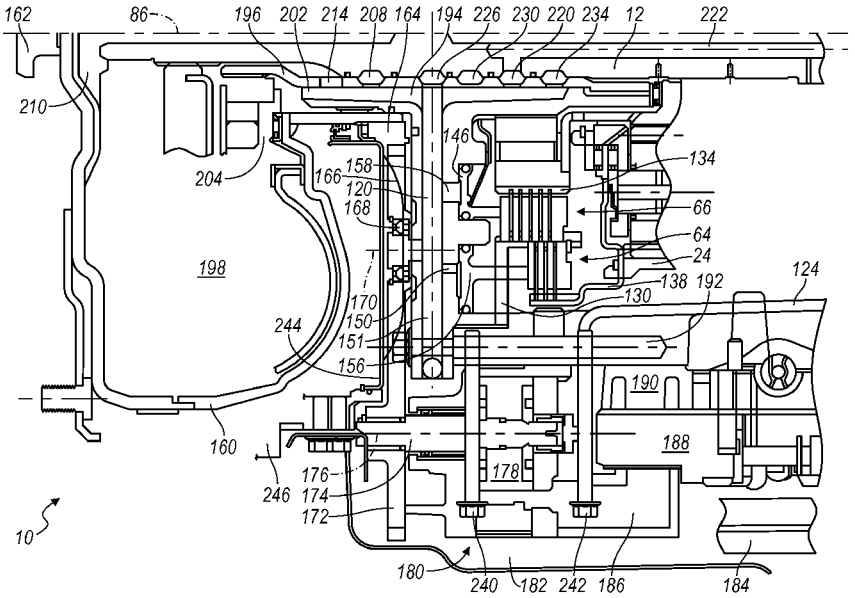
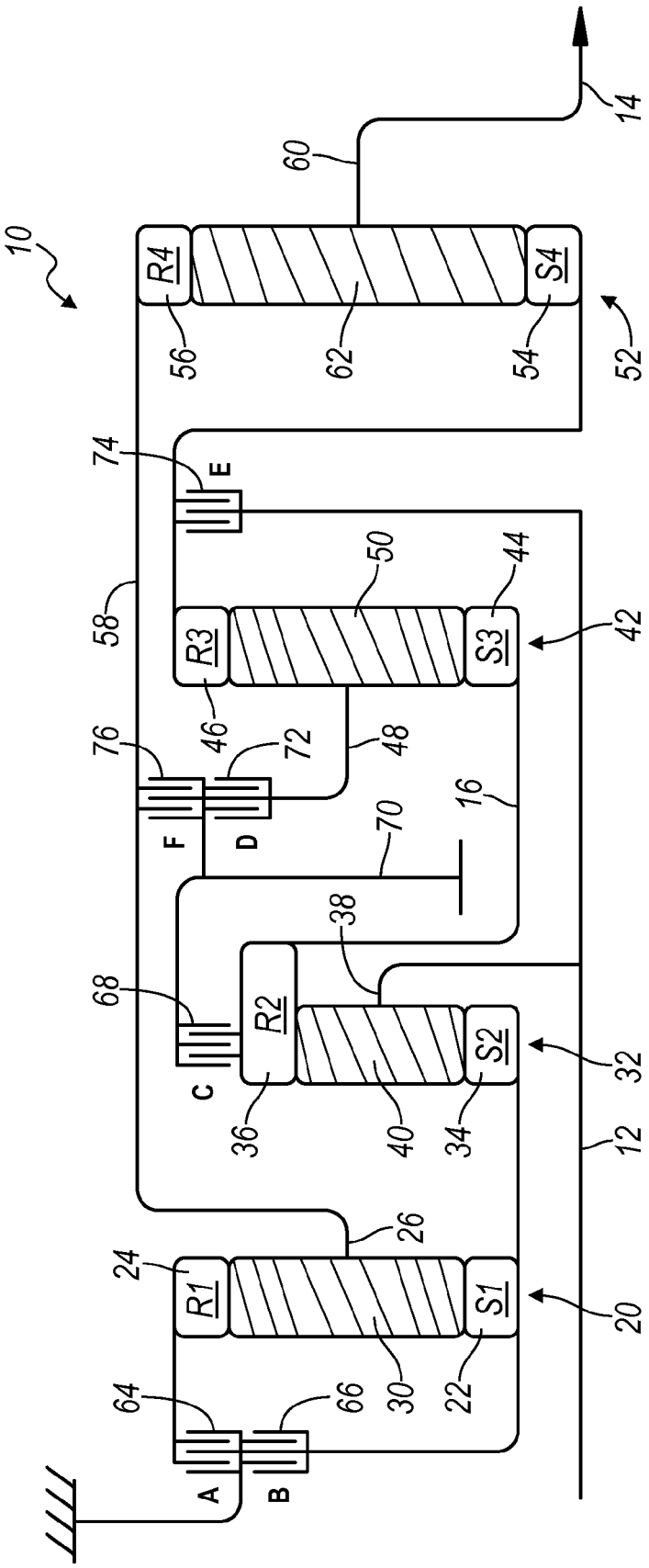
(57) **ABSTRACT**

A system for supplying fluid to transmission control elements includes a body producing clutch-apply pressures and a lube source, clutches, each clutch including a servo and a balance volume, a shaft including passages, a support including paths communicating each of the clutch-apply pressures and the lube source to a respective passage, and a clutch hub communicating clutch-apply pressure from each of the passages to a respective servo, and communicating the lube source to the balance volumes.

18 Claims, 6 Drawing Sheets

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D
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68
R2
S2
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12
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S1
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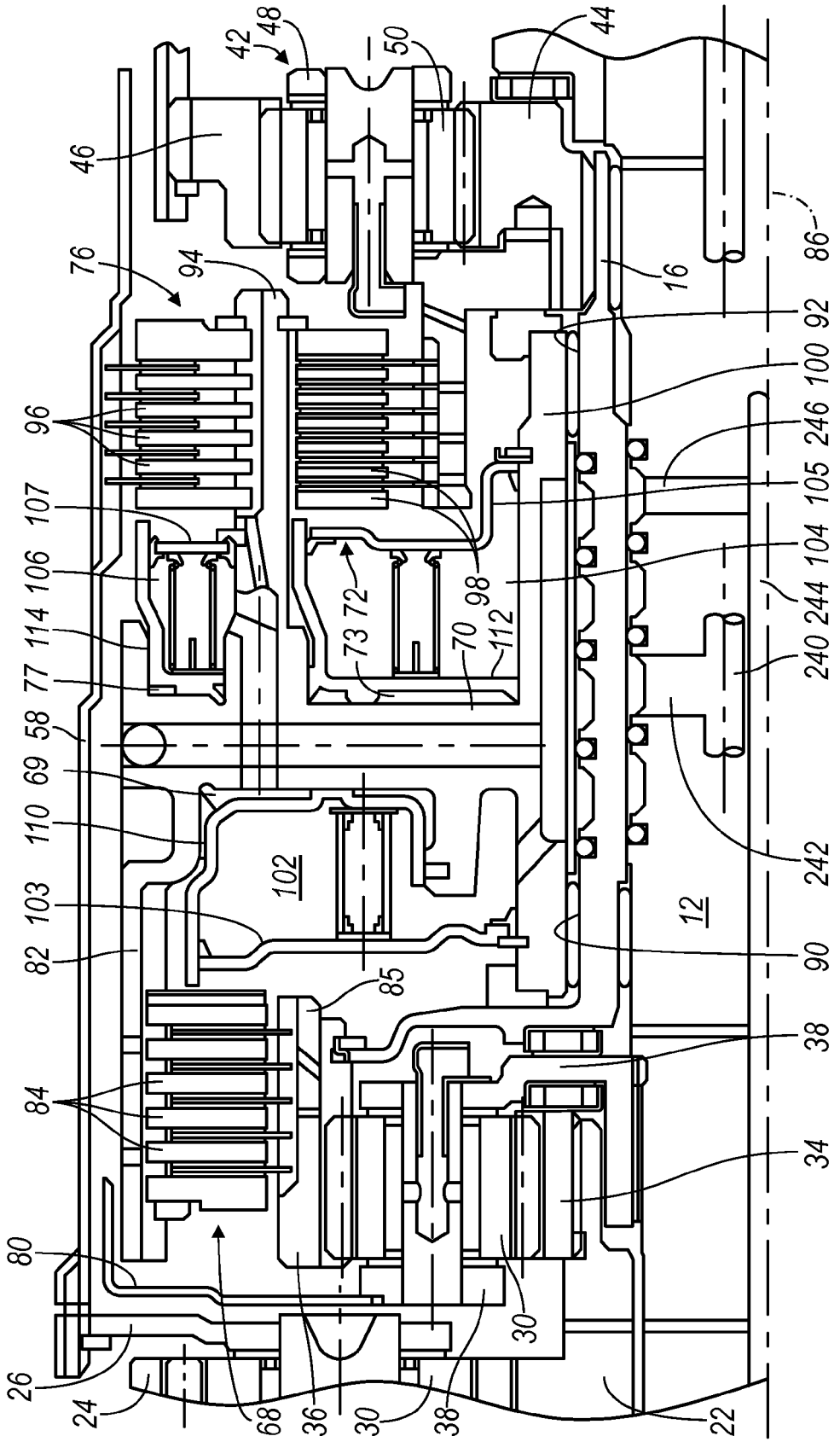
A
B

FIG. 1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84
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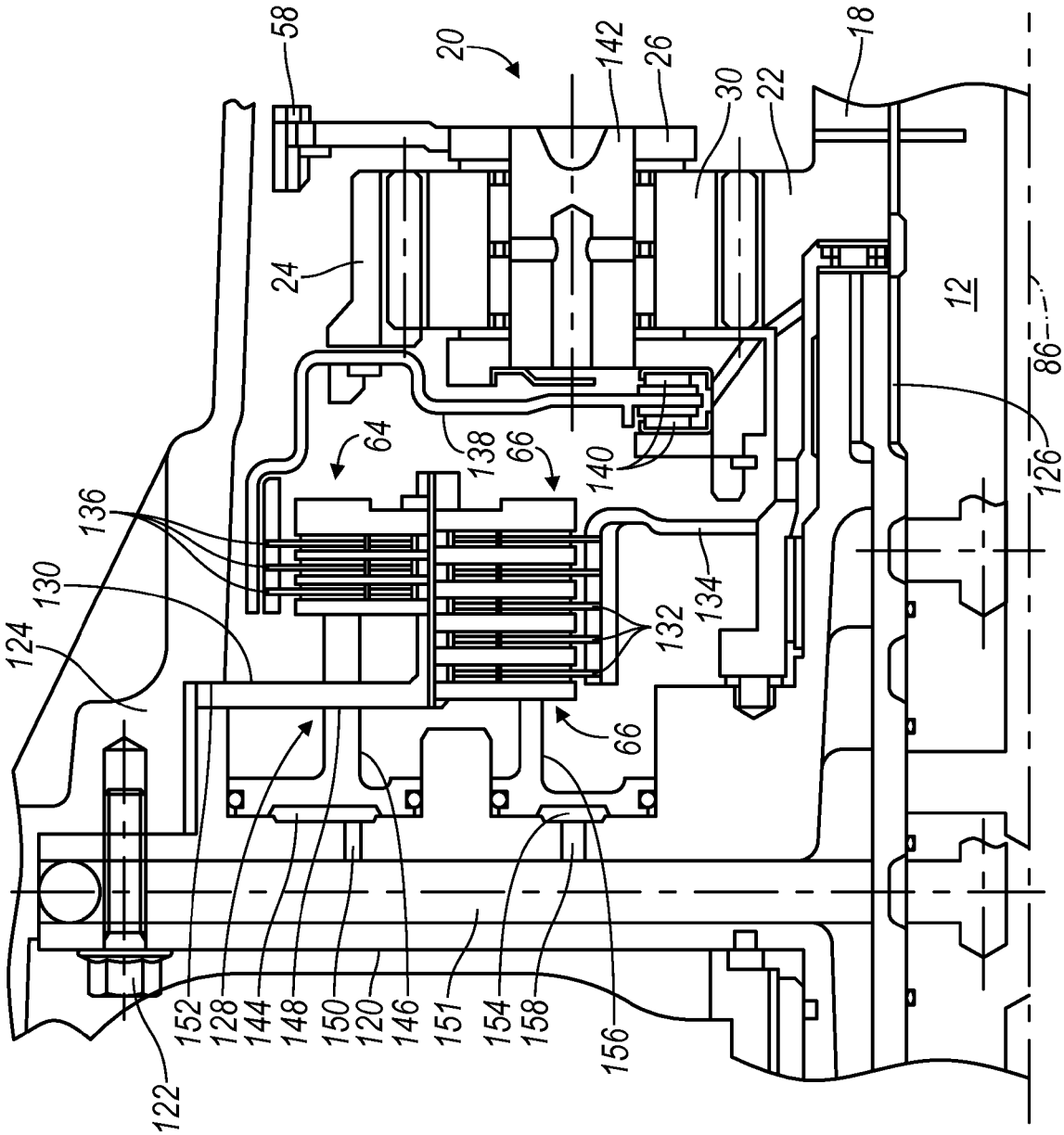
FIG. 2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142
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12
86
64
138
66
140
126
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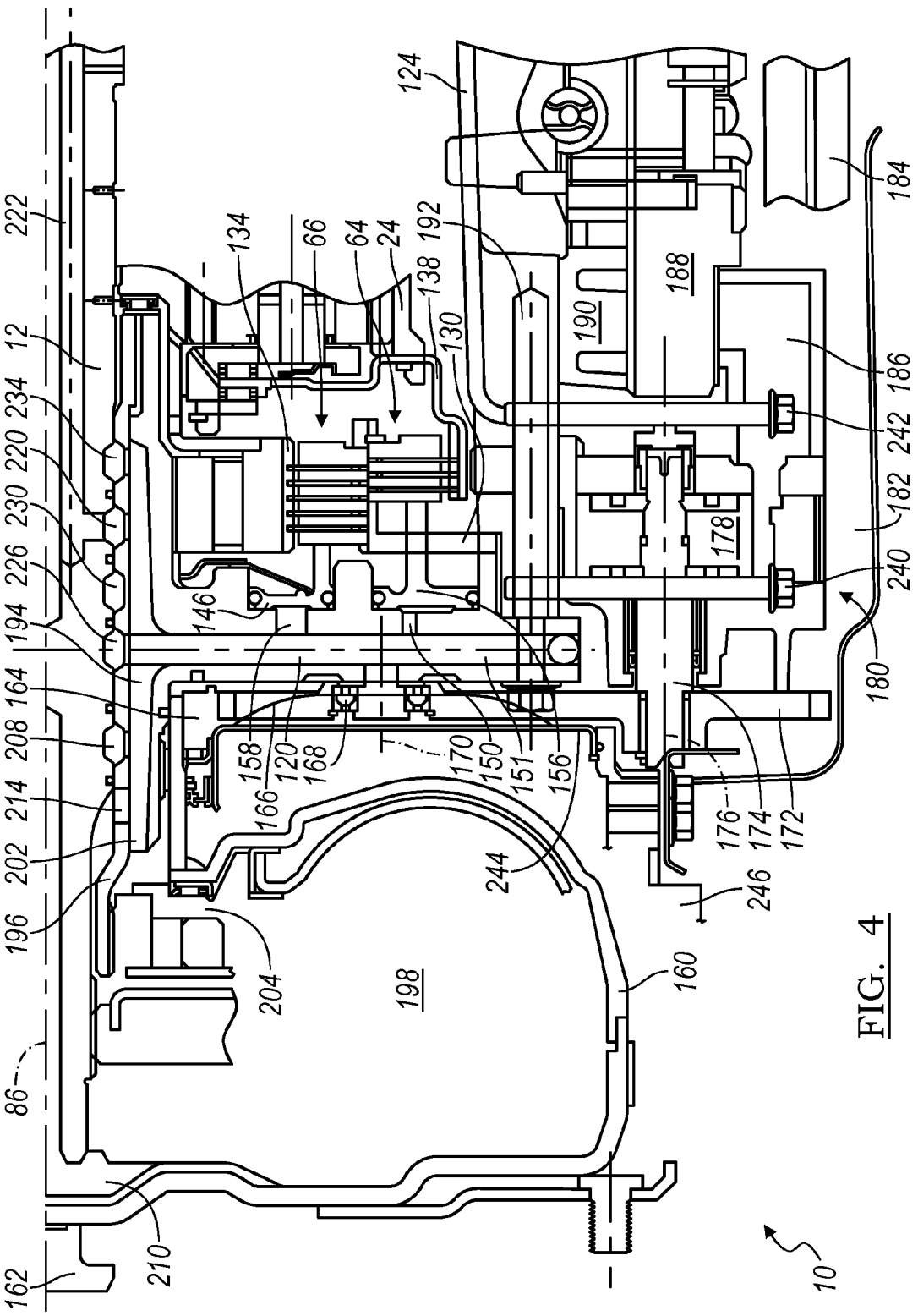
FIG. 3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12
234
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194
164
208
214
202
196
86
162
210
134
66
64
24
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192
124
184
188
190
130
186
242
182
178
240
180
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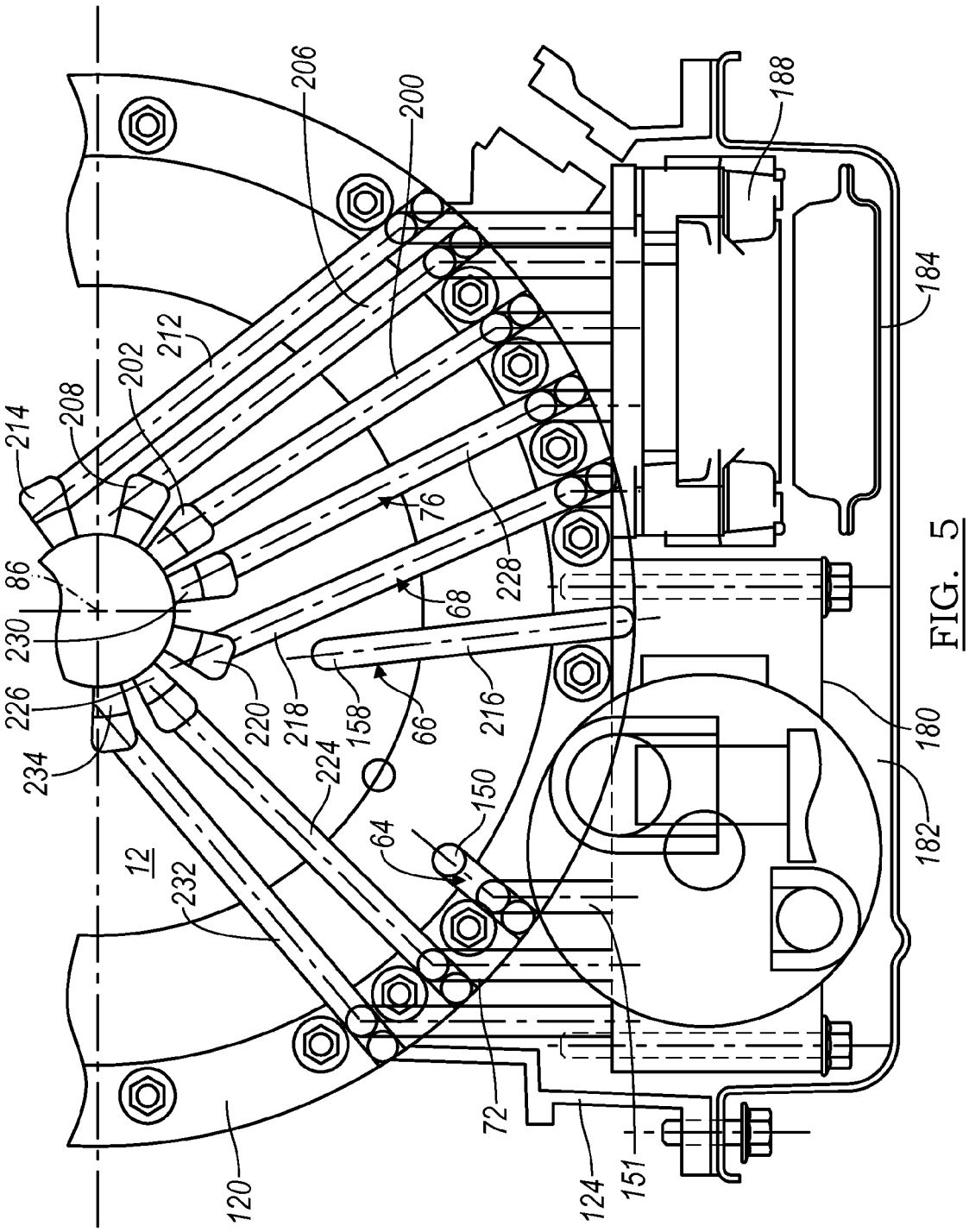
198
160
10

FIG. 4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200
188
184
212
202
208
214
86
230
226
234
76
68
228
220
218
158
66
216
224
150
64
12
232
72
120
124
151
180
182

FIG. 5

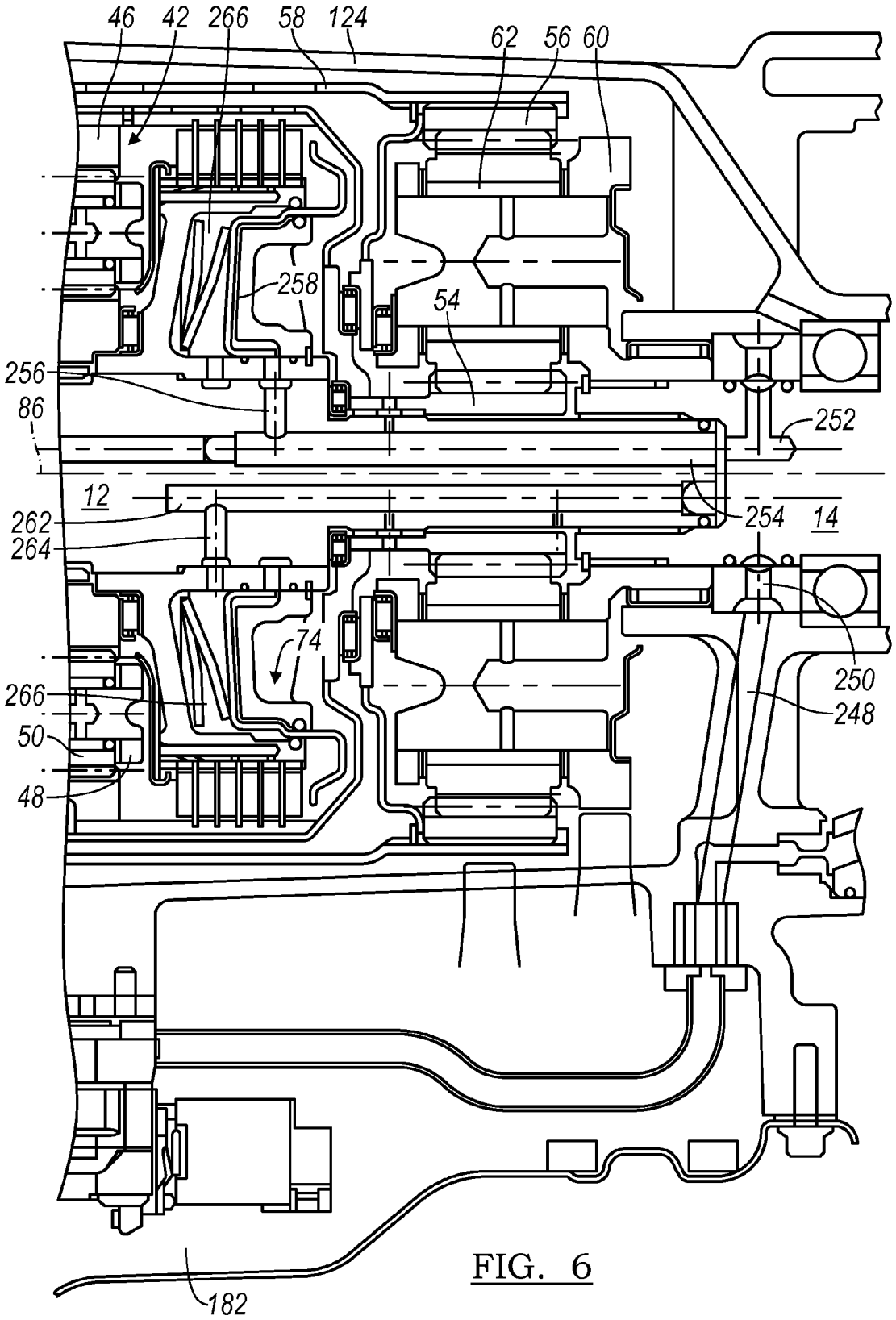
46
42
266
58
124
62
56
60
258
54
256
86
252
12
262
264
254
14
74
250
248
266
50
48
182

FIG. 6

SYSTEM FOR SUPPLYING FLUID TO TRANSMISSION CONTROL ELEMENTS

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to an apparatus for supplying fluid to clutch and brake control elements of an automatic transmission and to a transmission lube circuit.

2. Description of the Prior Art

An automatic transmission for a motor vehicle capable of producing a large number of forward gear ratios may require several brakes and four or more clutches to control its operation. In addition such a transmission may require two or three passages of oil feed to its torque converter.

A need exists in the industry for a technique that feeds automatic transmission fluid (ATF) to the torque converter, clutches, brakes and a lube circuit through a front support assembly such that the axial length of the transmission is minimized. The ATF must be supplied to a separate oil path for each clutch-apply circuit, the lube circuit and each of the torque converter circuits while providing sealing between the paths, adequate flow area, and connections from a hydraulic control body through the pump support.

SUMMARY OF THE INVENTION

A system for supplying fluid to transmission control elements includes a body producing clutch-apply pressures and a lube source, clutches, each clutch including a servo and a balance volume, a shaft including passages, a support including paths communicating each of the clutch-apply pressures and the lube source to a respective passage, and a clutch hub communicating clutch-apply pressure from each of the passages to a respective servo, and communicating the lube source to the balance volumes.

In conventional automatic transmissions having multiple rotating clutches and a three-passage torque converter, an extra support structure in the center of the trans (called a center support) is required to allow passage of one or more of the rotating clutches. This system provides feeds for all the clutches and the lube circuit without adding a center support.

The scope of applicability of the preferred embodiment will become apparent from the following detailed description, claims and drawings. It should be understood, that the description and specific examples, although indicating preferred embodiments of the invention, are given by way of illustration only. Various changes and modifications to the described embodiments and examples will become apparent to those skilled in the art.

DESCRIPTION OF THE DRAWINGS

The invention will be more readily understood by reference to the following description, taken with the accompanying drawings, in which:

FIG. **1** is a schematic diagram of the kinematic assembly of an automatic transmission for a motor vehicle;

FIG. **2** is a cross sectional side view of an intermediate length portion of the kinematic assembly of FIG. **1** showing a clutch housing;

FIG. **3** is a cross sectional side view of a front length portion of the kinematic assembly of FIG. **1** showing a brake assembly;

FIG. **4** is a cross sectional side view of a length portion of the kinematic assembly of FIG. **1** showing hydraulic passages;

FIG. **5** is a cross sectional end view in the pump support showing hydraulic passages; and

FIG. **6** is a cross sectional side view of a length portion of the kinematic assembly of FIG. **1** showing hydraulic passages that supply the rear clutch.

DESCRIPTION OF THE PREFERRED EMBODIMENT

The assembly **10** FIG. **1** includes an input **12**; output **14**; intermediate shaft **16**; a first planetary gear set **20** having a first sun gear **22**, a first ring gear **24**, a first carrier **26**; and a set of planet pinions **30** supported on carrier **26** and in continuous meshing engagement with the sun gear **22** and the ring gear **24**.

A second planetary gear set **32** includes a second sun gear **34** fixedly coupled to sun gear **22**; a second ring gear **36**; a second carrier **38** fixedly coupled to the input **12**; and a set of planet pinions **40** in supported on carrier **38** and in continuous meshing engagement with sun gear **34** and ring gear **36**.

A third planetary gear set **42** includes a third sun gear **44** fixedly coupled to ring gear **36**; a third ring gear **46**; a third carrier **48**; and a set of planet pinions **50** supported on carrier **48** and in continuous meshing engagement with sun gear **44** and ring gear **46**.

A fourth planetary gear set **52** includes a fourth sun gear **54** fixedly coupled to ring gear **46**; a fourth ring gear **56** fixedly coupled by a shell **58** to carrier **26**; a fourth carrier **60** fixedly coupled to output **14**; and a set of planet gears **62** supported on carrier **60** and in continuous meshing engagement with sun gear **54** and ring gear **56**.

A first brake **64** selectively holds ring gear **24** against rotation.

A second brake **66** selectively holds sun gears **22**, **34** against rotation on the transmission case **124**.

A first clutch **68** selectively couples ring gear **36** to a clutch housing **70**.

A second clutch **72** selectively couples carrier **48** to clutch housing **70**.

A third clutch **74** selectively couples ring gear **46** and sun gear **54** to input **12**.

A fourth clutch **76** selectively couples shell **58** to clutch housing **70**.

FIG. **2** shows that carrier **26** is secured to shell **58**.

Clutch housing **70** includes an axial arm **82** formed with internal spine teeth, to which external teeth on the spacer plates **84** of clutch **68** are fixed for rotation with clutch housing **70**. The friction plates of clutch **68** are splined to external spline teeth formed on a ring **85**, which is formed with ring gear **36**.

Intermediate shaft **16**, which extends along axis **86** on the radial outer side of input **12**, is secured to ring **85** where a snap ring **88** completes the connection. Clutch housing **70** is supported by axially spaced bushings **90**, **92** on the radial outer surface of intermediate shaft **16**.

Clutch housing **70** includes another axial arm **94** formed with external spine teeth, to which internal teeth on the spacer plates **96** of clutch **76** are fixed for rotation with clutch housing **70**. The friction plates of clutch **76** are splined to internal spline teeth formed on a shell **58**.

External teeth **98** on the spacer plates of clutch **72** engage internal spline teeth formed on arm **94** of the clutch housing **70**. The friction plates of clutch **72** are splined to external spline teeth formed on carrier **48**.

Located between bushings **90**, **92** and formed in the hub **100** of clutch housing **70** are four feed circuits. A single balance oil feed supplies automatic transmission fluid (ATF)

to the pressure balance volumes **102**, **104**, **106** of clutches **68**, **72**, **76**. Balance dams **103**, **105**, **107** seal the pressure balance volumes **102**, **104**, **106** at the pistons **110**, **112**, **114** of the clutches **68**, **72**, **76**.

Each of the servo cylinders **69**, **73**, **77** of clutches **68**, **72**, **76** is supplied with actuating pressure through individual circuits formed in the clutch housing **70**. When no actuating pressure is applied to clutches **68**, **72**, **76**, the clutch housing **70** has no fixed connection to any other component of assembly **10**.

FIG. **3** shows a pump support **120** secured by bolts **122** to the transmission case **124** and supporting the input shaft **12** on a bushing **126**. A hub **128** for brakes **64**, **66** includes a radial arm **130**, secured to the pump support, and an axial arm formed with external and internal axial splines, to which the spacer plates of the brake and clutch are secured, respectively.

The friction discs **132** of brake **66** are connected to external, axial spline teeth formed on a disc **134**, which is secured to the sun gears **22**, **34** through intermediate shaft **18**. The friction discs **136** of brake **64** are connected to internal, axial spline teeth formed on a disc **138**, which is secured to ring gear **24** and is supported between two thrust bearings **140** located on the carrier **26**.

The planet pinions **30** of gearset **20** are supported for rotation on a pinion shaft **142**, which is supported on carrier **26**.

Pump support **120** is formed with a first cylinder **144** containing a piston **146**, which extends though openings **148** into contact with one of the spacer plates of brake **64**. Brake-apply pressure is carried through passages **150**, **151** to cylinder **144**. The openings **148** in hub radial arm **130** allow an assembler of the brake hub assembly to see though the arm while aligning friction plates **136** with disc **138**.

Pump support **120** is also formed with a second cylinder **154** containing a piston **156**, which contacts one of the spacer plates of brake **66**. Brake-apply pressure is carried through passage **158** to second cylinder **154**.

The radial arm **130** of the brake hub **128** is secured to the transmission case **124** such that the arm contacts an axial stop **152**, which limits axial displacement of the arm and provides an axial reaction force to the force of piston **146** applied to the plates of brake **64** and the force of piston **156** applied to the plates of brake **66**.

FIG. **4** shows a torque converter **198** enclosed by an impeller housing **160**, **162**, which is driveably connected to an engine shaft or other power source. A drive **164** is driveably connected to impeller housing **160**. An idler gear **166**, supported on a bearing **168** and meshing with the drive gear, is driven by impeller housing **160** in rotation about axis **170**. A gear **172**, meshing with idler gear **166**, is connected by a spline to a rotor shaft **174**, which rotates about axis **176**.

The rotor **178** of a variable displacement pump **180**, secured to the rotor shaft **174**, draws automatic transmission fluid (ATF) into the pump's inlet from an oil sump **182**, through a filter **184** located in the sump. ATF exiting the outlet of pump **180** flows sequentially through passage **186**, a hydraulic control body **188**, a series of oil feed paths **190** and a series of drilled oil feed holes **192**. The oil feed holes **192** are formed in transmission case **124**.

The pump support **120** is formed with drilled oil feed paths directed toward axis **86** in the pump support **120**. Each oil feed path connects one of the drilled oil feed holes **192** with a corresponding oil feed channel **194**. Drilled holes in a torque converter stator shaft **196** connect each of the channels **194** to input shaft **12** and to the torque converter **198** located within housing **160**.

Referring now to FIGS. **4** and **5**, one of the oil feed holes **192** is connected by feed path **200** in pump support **120** to a feed channel **202**, through which the torque converter **198** is charged with ATF through passage **204**.

Another one of the oil feed holes **192** is connected by feed path **206** in pump support **120** to a feed channel **208**, through which a torque converter lockup clutch is actuated through passage **210**.

One of the oil feed holes **192** is connected by feed path **212** in pump support **120** to a feed channel **214**, through which the torque converter **198** is released.

FIG. **5** shows the feed path **151** and passage **150**, through which brake **64** is actuated.

One of the oil feed holes **192** is connected by feed path **216** in pump support **120** to passage **158**, through which brake **66** is actuated.

One of the oil feed holes **192** is connected by feed path **218** in pump support **120** to a feed channel **220**, connected though an axial passage **222** in input shaft **12**, through which clutch **68** is actuated.

One of the oil feed holes **192** is connected by feed path **224** in pump support **120** to a feed channel **226**, connected though an axial passage in input shaft **12**, through which clutch **72** is actuated.

One of the oil feed holes **192** is connected by feed path **228** in pump support **120** to a feed channel **230**, connected though an axial passage in input shaft **12**, through which clutch **74** is actuated.

One of oil feed holes **192** is connected by feed path **232** in pump support **120** to a feed channel **234**, connected though an axial passage in input shaft **12**, through which a lube circuit is supplied. The lube circuit carries ATF to the balance volumes of clutches **68**, **72**, **74**, **76** through axial passage **262**, as shown in FIG. **6**.

Each of the four axial passages in input shaft **12**, through which clutches **68**, **72**, **74** are actuated and the lube circuit is supplied, is mutually parallel and parallel to axis **86**.

Three of the axial passages in input shaft **12** communicate through clutch housing **70** to the servo cylinders of clutches **68**, **72**, **74** through oil feed paths in the clutch housing similar to those described with reference to the pump support **120** of FIGS. **4**, **5**. The axial lube passage in input shaft **12** also communicates through clutch housing **70** to the balance volumes **102**, **104**,**106** of clutches **68**, **72**, **74** through oil feed paths in the clutch housing **70** similar to those described with reference to the pump support **120**.

FIG. **2** shows the axial **240** and radial **242** passages, through which clutch-apply pressure is supplied to clutch **72**, and the axial **244** and radial **246** passages, through which lube is supplied to the balance volumes **102**, **104**, **106** of clutches **68**, **72**, **76**, respectively.

FIG. **6** is a cross sectional side view of a rearward portion of the kinematic assembly of FIG. **1** showing hydraulic passages that supply lube and clutch-apply pressure to clutch **74**. A passage **248** carries fluid from the control body **188**, through the oil sump **182** and transmission case **124**, to a radial passage **250** formed in the output shaft **14**. Aligned and connected axial passages **252**, **254** in output shaft **14** and input shaft **12**, respectively, hydraulically connect passage **250** and radial passage **256**, which carries clutch-apply pressure to the cylinder **258** of the servo that actuates clutch **74**.

The same lube passage **262** in input shaft **12** that carries lube to clutches **68**, **72**, **76** also carries ATF lube to clutch **74** from source of lube in control body **188**. Axial passage **262** in input shaft **12** is hydraulically connected to a radial passage **264**, which carries lube to the balance volume **266** of clutch **74**.

In accordance with the provisions of the patent statutes, the preferred embodiment has been described. However, it

should be noted that the alternate embodiments can be practiced otherwise than as specifically illustrated and described.

The invention claimed is:

1. A system for supplying fluid to transmission control elements, comprising:

a body producing clutch-apply pressures and a lube source;

clutches, each clutch including a servo and a balance volume;

a shaft including passages;

a support including paths communicating each of the clutch-apply pressures and the lube source to a respective passage;

a clutch hub communicating clutch-apply pressure from each of the passages to a respective servo, and communicating the lube source to the balance volumes;

a torque converter including a lock-up clutch passage; and

wherein the body produces lock-up clutch pressure, and the support paths include a path that communicates lock-up clutch pressure to the lock-up clutch passage.

2. The system of claim **1**, wherein:

the body produces a clutch-apply pressure for each of three of the clutches;

the shaft passages include four passages, each of first, second and third of the passages communicating clutch-apply pressure to one of the clutch servos, and a fourth passage communicating the lube source to the balance volumes.

3. The system of claim **1**, further comprising:

brakes, each brake including a brake servo; and

wherein the body produces brake-apply pressures, and the support includes second paths that communicate each of the brake-apply pressures to a respective brake servo.

4. The system of claim **1**, further comprising:

a brake including a brake servo; and

wherein the body produces brake-apply pressure, and the support includes a path that communicates the brake-apply pressure to the brake servo.

5. The system of claim **1**, further comprising:

the torque converter including a converter charge passage; and

wherein the body produces converter charge pressure, and the support paths include another path that communicates converter charge pressure to the converter charge passage.

6. The system of claim **1**, further comprising:

the torque converter including a converter release passage; and

wherein the body produces converter release pressure, and the support paths include another path that communicates converter release pressure to the converter release passage.

7. A system for supplying fluid to transmission control elements, comprising:

a body including a lube source and producing clutch-apply pressures for each of three clutches, each clutch including a respective servo and a balance volume;

an input shaft including four passages, each of first, second and third of the passages communicating clutch-apply pressure to one of the clutch servos, and a fourth passage communicating the lube source to the balance volumes of the clutches;

a fourth clutch including a fourth servo and a fourth balance volume;

an output shaft including a fourth clutch-apply passage, the output shaft including a fifth passage that communicates the fourth clutch-apply passage to the fourth servo, the fourth passage communicating the lube source to the fourth balance volume;

a hydraulic path communicating clutch-apply pressure from the body to the fourth clutch-apply passage.

8. The system of claim **7**, further comprising:

brakes, each brake including a brake servo;

the body produces brake-apply pressures; and

a support that includes paths that communicate each of the brake-apply pressures to a respective brake servo.

9. The system of claim **7**, further comprising:

a brake including a brake servo;

the body produces brake-apply pressure; and

a support includes a path that communicates the brake-apply pressure to the brake servo.

10. The system of claim **7**, further comprising:

a torque converter including a converter charge passage; and

the body produces converter charge pressure; and

a support that includes a path that communicates converter charge pressure to the converter charge passage.

11. The system of claim **7**, further comprising:

a torque converter including a lock-up clutch passage;

the body produces lock-up clutch pressure; and

a support that includes a path that communicates lock-up clutch pressure to the lock-up clutch passage.

12. The system of claim **7**, further comprising:

a torque converter including a converter release passage;

wherein the body produces converter release pressure; and

a support that includes a path that communicates converter release pressure to the converter release passage.

13. A system for supplying fluid to transmission elements, comprising:

a shaft including passages;

a lube source;

a support including fluid paths communicating clutch-apply pressures and the lube source to a respective passage;

a clutch hub containing clutches, each clutch including a servo and a balance volume spaced axially from the support, the clutch hub communicating clutch-apply pressure from each of the passages to a respective servo, and communicating the lube source to the balance volumes;

a torque converter including a lock-up clutch passage; and

wherein a control body produces lock-up clutch pressure, and the support paths include a path that communicates lock-up clutch pressure to the lock-up clutch passage.

14. The system of claim **13**, wherein:

the control body produces a clutch-apply pressure for each of three of the clutches;

the shaft passages include four passages, each of first, second and third passages communicating clutch-apply pressure to one of the clutch servos, and a fourth passage communicating the lube source to the balance volumes.

15. The system of claim **13**, further comprising:

the control body producing brake-apply pressures;

brakes, each brake including a brake servo; and

wherein the support includes second paths that communicate each of the brake-apply pressures to a respective brake servo.

16. The system of claim **13** further comprising:

the control body producing a brake-apply pressure;

a brake including a brake servo; and

wherein the support includes a path that communicates the brake-apply pressure to the brake servo.

17. The system of claim 13, further comprising:

the torque converter including a converter charge passage; and

wherein the control body produces converter charge pressure, and the support paths include a path that communicates converter charge pressure to the converter charge passage.

18. A system for supplying fluid to transmission control elements, comprising:

a body producing clutch-apply pressures and a lube source;

clutches, each clutch including a servo and a balance volume;

a shaft including passages;

a support including paths communicating each of the clutch-apply pressures and the lube source to a respective passage;

a clutch hub communicating clutch-apply pressure from each of the passages to a respective servo, and communicating the lube source to the balance volumes;

a torque converter including a converter release passage; and

wherein the body produces converter release pressure, and the support paths include a path that communicates converter release pressure to the converter release passage.

* * * * *